The World Trade Center: An Architectural and Engineering Milestone
by Robert E. Rapp, P. E.

The World Trade Center, to be built by the Port of New York Authority on the lower West side of Manhattan in New York City, has been referred to by the Authority as an innovation in steel design. It may also be described as a major milestone in structural steel design. The remarkable features incorporated into the design of the towers for the Trade Center promise to set the direction and scope for a new class of high-rise buildings. The 110-story twin towers will soar over New York City to a height of more than 1350 feet, higher than any building ever constructed. Each tower will be 209 feet square with 43,000 square feet per floor. The total rentable area for the Center will be 10,000,000 square feet.

A structural engineer receiving specifications for such a building just four years ago would have been faced with an almost impossible task. Today, however, this engineering wonder is being made possible by the engineering ingenuity of John Skilling and Leslie E. Robertson of Worthington, Skilling, Hele and Jackson, through the use of various grades of steel made available only in recent years. Because of the specified design concepts and erection procedures, shop fabrication and field erection costs will be reduced to a minimum for a structure of this magnitude. The towers require approximately 40 percent less structural steel than would be required for buildings designed by more conventional methods; yet the structure has been designed to resist wind loads of 45 pounds per square foot over the entire face from the street to roof line. This is more than two times the New York City Code requirements and far in excess of the design load for any other New York City building. Likewise, there is built-in reserve strength to resist damage from an explosion or an extensive fire. This has been accomplished by continuity of construction and unique employment of high strength steels. If one area of the building becomes overstressed, the over-stress is evenly distributed throughout the entire structural system. This system has enough reserve strength to withstand between 400 and 2200 per cent increase in live loads based on factors of safety from 1.8 to 5.4 respectively. Yet the weight of steel in this structural system does not exceed 37 pounds per square foot. This weight is exceptionally low for a building of this size.

This article will explain the basic engineering principles that will be employed to achieve the required aesthetic features, functionality, economy, speed of erection and maximum stability.

Construction of Superstructure... The occupancy space requirements will be met by what the architects and engineers refer to as the "sky lobby" system. The "sky lobby" acts as an elevated station to change from high-speed express elevators for local elevators. It is estimated that transportation time to any point in the building, including transfer, will not exceed two minutes. Likewise, the estimated maximum waiting time, even during rush hours, will not exceed two minutes. Comparison of elevator shaft areas to usable space areas is shown in Figure 1. There is approximately 75 per cent of the total floor area available for tenant occupancy in the "sky lobby" system compared to only 52 per cent in a more conventional design.

The World Trade Center Design Team

Two of the world's leading architectural firms, Minoru Yamasaki and Associates of Birmingham, Michigan, and Emery Roth & Sons of New York City, developed the plans for the World Trade Center. They were assisted by the World Trade Center Planning Division under the direction of Malcolm P. Levy, Chief, and the Port Authority Engineering Department under the direction of John M. Kyle, Chief Engineer. Also assisting them have been the consulting firms of Jaros, Baum & Bolles, mechanical engineers and Joseph R. Loring and Associates, electrical engineers, both of New York City. The structural consultants are Worthington, Skilling, Hele & Jackson of Seattle, Washington.